FOSSIL PLANTS FROM JAPAN AND KOREA

FOSSIL PLANTS FROM JAPAN AND KOREA

BY

SABURÔ ÔISHI

With 1 Plate

CONTENTS

INTRODUCTION

In Part I are described six species of fossil plants derived from the Mesozoic strata recently discovered on the sea-coast of Takata, near Minoshima, Prov. Kii, and collected by Dr. T. NAGAO and myself. The plant beds of Takata belong to the Ryôseki Series. In Part II are described three interesting forms of fossil plants from Korea, collected by Professor H. YABE, together with another specimen from Korea donated by Dr. S. TOKUNAGA of the Waseda University in Tôkyô to our Institute of Geology and Palaeontology. I wish here to acknowledge his indebtedness to Professor YABE for the constant help and suggestion which he has given through the course of the present work.

I. MESOZOIC PLANTS FROM TAKATA, PROV. KII, JAPAN

The Mesozoic plant-beds of Takata were discovered in the spring of 1926 by a party of students of the Institute of Geology and Palaeontology, Tôhoku Imperial University, on the occasion of a geological excursion directed by Dr. T. NAGAO. The writer who also took part in that excursion brought back a number of specimens of plant fossils described in the following pages. The geological note of the excursion was published in Japanese by Dr. NAGAO[1] in the Journal of the Geological Society of Tôkyô in 1926.

The Mesozoic strata with plant-beds occupy a small area on the sea-coast of the village of Takata, 3 km. south of the town of Minoshima, Arita-gun, Prov. Kii, and are divisible, according to Dr. NAGAO, as follows, in descending order:

(d) Black shale about 6 m. in thickness, with marly nodules and layers of lenticular limestone; shell-fragments like *Inoceramus*-shells showing a prismatic structure in section particularly abundant.

(c) Greenish sandstone in the upper part, and conglomerate in the lower; the conglomerate with water-worn pebbles of quartzite, sandstone and hornstone, sometimes exceeding 30 cm. in diameter. No limestone pebbles. Total thickness over 30 m.

(b) Greenish-gray compact sandstone and sandy-shale with thin layers of black coloured shale, containing 3 or 4 plant-beds. Total thickness 10 m.

[1] T. NAGAO: On Some Facts concerning the Mesozoic Formation in Arita-gun, Prov. Kii. Jour. Geol. Soc. Tôkyô, Vol. XXXIII, No. 399, 1926, p. 378.

(a) Basal conglomerate of 6 m. in thickness, containing pebbles of reddish and white quartzite, schalstein (?), greenish schistose rocks, etc., also often large blocks reaching 1 m. in diameter. A red shale bed of about 30 cm. in thickness at about 2 m. above the base.

. . . . . Unconformable . . . . . .

Green slate and black phyllitic slate (Chichibu System ?).

From the plant-beds (b) Dr. NAGAO recorded the following species,

Onychiopsis mantelli (BRONGN.)
Cladophlebis browniana (DKR.)
Ruffordia goepperti (DKR.)
Acrostichopteris longipennis FONT.

on the provisional determination of the writer, and Prof. YABE[1] also quoted these specific names in his "Cretaceous Stratigraphy of the Japanese Islands."

The followings are the species here described, with a slight alteration of the previous determination and with the addition of three more species:

Equisetites sp. (Reg. No. 38390)
Cladophlebis browniana (DUNKER) (Reg. No. 38450)
Cladophlebis? sp. (Reg. No. 38389)
Onychiopsis psilotoides (STOKES and WEBB) (Reg. No. 38457)
Sphenopteris goepperti DUNKER (Reg. No. 38388)
Carpolithus sp. (Reg. No. 38391).

Acrostichopteris longipennis FONT. in the previous determination is included in *Sphenopteris goepperti* on ground mentioned in the descriptive part.

DESCRIPTION OF THE SPECIES

Equisetites sp.

Pl. XXXVI (I), Fig. 1.

A single specimen of the subaerial branch of an Equisetacean plant in the collection is shown in Fig. 1. It represents an internodal portion at least 3 cm. in length, and 7 mm. in breadth, and there are seven longitudinal ridges alternating with broad grooves. It resembles somewhat a wide-spread Wealden species *Equisetites burchardti* DUNKER,[2] and *Equisetum virginicum* FONTAINE[3] from the Potomac of North America. In the absence of any leaf-sheath, node, or any other characters suitable for specific distinction, it is impossible to determine the specimen specifically.

---

[1]H. YABE: Cretaceous Stratigraphy of the Japanese Islands. Sci. Rep. Tôhoku Imp. Univ., Sendai, 2nd Ser. (Geology), Vol. XI, 1927, p. 41. There is some confusion in the specific names given in his list of fossil plants from Takata on one side and Tennohama and Mizutani on the other. The corrected list is as follows:—Takata: *Cladophlebis browniana* (DKR.), *Onychiopsis psilotoides* (STOKES and WEBB), *Sphenopteris goepperti* DKR., *Acrostichopteris* cfr. *longipennis* FONTAINE; Tennohama and Mizutani:—*Cladophlebis browniana* (DKR.), *Cladophlebis nathorsti* YOK., *Onychiopsis elongata* (GEYL.), *Adiantites yuasensis* YOK., *Sphenopteris goepperti* DKR., *Hausmannia?* sp., *Zamiophyllum buchianum* ETT., *Glossozamites parvifolius* YOK., *Nilssonia schaumburgensis* (DKR.), *Nilssonia pterophylloides* YOK., *Ptilophyllum pecten* (PHILLIPS), *Podozamites lanceolatus* (L. and H.), *Torreya venusta* YOK.

[2]Cfr. A. C. SEWARD: Wealden Flora, Pt. I, 1894, p. 27.

[3]W. M. FONTAINE: The Potomac or Younger Mesozoic Flora. U. S. Geol. Surv. Mon., Vol. XV, 1889, p. 63, Pl. I, Figs. 1–8; Pl. II, Figs. 1–3, 6, 7, 9.

Cladophlebis browniana (DUNKER)

Pl. XXXVI (I), Figs. 2-4.

1846. *Pecopteris browniana* DUNKER: Monographie der norddeutschen Wealdenbildung, p. 5, Pl. VIII, Fig. 7.

? 1877. *Pecopteris exiliformis* GEYLER: Ueber fossile Pflanzen aus der Jura-Formation Japans. Palaeontographica, Vol. 24, p. 226, Pl. XXX, Figs. 1a, b.

1903. *Cladophlebis browniana* SEWARD: Fossil Floras of Cape Colony. Ann. S.-African Museum, Vol. IV, Pt. I, p. 10, Pl. XI, Figs. 1-4, 6.

? 1905. *Cladophlebis* cfr. *dunkeri* YABE: Mesozoic Plants from Korea. Journ. Coll. Sci., Imp. Univ. Tôkyô, Vol. XX, Pt. 8, p. 37, Pl. IV, Fig. 9.

1907. *Cladophlebis browniana* KNOWLTON: Description of a Collection of Kootanie Plants from the Great Falls Coal Field of Montana. Smithsonian Misc. Coll., Vol. IV, Pt. I, p. 110, Pl. XI, Figs. 1, 1a.

1922. *Cladophlebis browniana* YABE: Notes on Some Mesozoic Plants from Japan, Korea and China. Sci. Rep. Tôhoku Imp. Univ., Sendai, 2nd Ser. (Geology), Vol. VII, No. 1, p. 5, Pl. I, Figs. 7-11; Text-fig. 4.

1926. *Cladophlebis browniana* NAGAO: On Some Facts concerning the Mesozoic Formation in Arita-gun, Prov. Kii; *loc. cit.*, p. 380.

1928. *Cladophlebis browniana* YABE: Cretaceous Stratigraphy of the Japanese Islands; *loc. cit.* p. 41 (in the table, the occurrence of this species from Takata is misprinted. See the corrected list on p. 108 (2), foot-note).

For further references see YABE, 1922, *loc. cit.*

This species seems to be rather common in the plant-beds of Takata; the specimens of it collected are, however, all fragmental, some of them being shown in Figs. 2-4. There is a single specimen in the collection which represents a small portion of a penultimate pinna, with ultimate pinnae attached to the slender rachis; this specimen being unsatisfactory in preservation is not illustrated at this place. Though the other specimens figured are all fragments of ultimate pinnae, they agree well with *C. browniana* in all respects, and I have little doubt about their specific determination. The nervation is mostly invisible, owing to the coarseness of the matrix on which the specimens are impressed; only a small fragment of pinna impressed on the back surface of a rock-piece with *Sphenopteris goepperti* shows its nervation to be of the usual *Cladophlebis*-type, the midnerve sending off secondary nerves once dichotomous.

It is generally accepted that YOKOYAMA's *Pecopteris exilis*[1] from Shimamura, Prov. Kaga, Japan, is specifically identical with *C. browniana* which, in the shape of pinnules, resembles very closely *Klukia exilis* from the Oolite of Yorkshire, originally described by PHILLIPS[2] as *Pecopteris exilis;* but no sporangia of the typical *C. browniana* has yet been figured by any authors. ZEILLER[3] once recorded from the Wealden of Peru a fossil plant identical with or closely allied to *C. browniana* which bears sporangia of the type characterising the Schizaeacae; Berry later regarded the specimen ZEILLER's from Peru as a distinct species and called it *Klukia zeilleri*

[1] M. YOKOYAMA: Jurassic Plants from Kaga, Hida and Echizen. Journ. Coll. Sci., Imp. Univ. Tôkyô, Vol. III, Pt. I, 1889, p. 35, Pl. I, Figs. 8-10, 9a.

[2] J. PHILLIPS: Geology of Yorkshire. Pt. I. The Yorkshire Coast. Sec. Edit., 1835, p. 119, Pl. VIII, Fig. 16.

[3] R. ZEILLER: Sur quelque plantes wealdiennes du Perou. Comp. Rend., Vol. 150, 1910, p. 1488.

BERRY.[1] In *Klukia exilis*, fertile pinnules carry 3–4 sori arranged in two rows, one on either side of the midnerve, and it is very interesting to note that similar fertile pinnules have been figured on *Cladophlebis browniana* by YOKOYAMA[2] and YABE[3] from Kaisekiyama and Omoto respectively. The Institute of Geology and Palaeontology, Tôhoku Imperial University, has a number of specimens of *C. browniana* derived from the Ônosawa[4] Group of the so-called Sanchû Graben in the Kwantô Mountainland, near Tôkyô; on some of the pinnules, we can see 3–4 rounded sori arranged on both sides of the midnerve just as on those from Omoto (YABE: 1913, *loc. cit.*, Pl. I, Fig. 10), together with typical sterile specimens of *C. browniana*, but no more detailed characters of the sori can be made out. *C. koraiensis* YABE[5] from the Naktong Series of Korea is often compared with *K. exilis*, both having the same arrangement of sori, but it can be distinguished sharply from *K. exilis* and the related species *C. browniana* in the rather acuminate apex of the pinnules and the acute angle between the pinnules and the pinna-rachis. These features of *C. koraiensis* rather recall certain species of *Gleichenites*, as, for instance, *G. zippei*. *Pecopteris virginiensis* FONTAINE,[6] which was later included by BERRY[7] in *C. browniana*, is certainly distinct from *C. browniana* from Japan in the position and form of the soral impression, and gives quite a different aspect on the habit of the fronds.

Cladophlebis ? sp.

Pl. XXXVI (I), Fig. 5.

The specimen in Fig. 5 consists of a very slender axis of 1.5 cm. in the maximum length and several long and narrow pinnules which are 0.7 cm. in breadth and 3.5 cm. in length. They are attached perpendicularly to the pinna-axis by the whole base, and narrowly spaced, the interspaces between each two adjacent pinnules being as broad as one half breadth of the pinnules. The midnerve only is faintly visible.

This specimen is different from the usual type of *C. browniana* in the longer and narrower and more distant habit of the pinnules, and more or less resembles *Pecopteris ungeri* DUNKER[8] and *P. conybeari* DUNKER[9]=*Matonidium goepperti* (ETT.) from the Wealden of Germany. Without further material for comparison, it is impossible to determine this specimen specifically or even generically.

Onychiopsis psilotoides (STOKES and WEBB)

Pl. XXXVI (I), Figs. 6–10.

1828. *Sphenopteris mantelli* BRONGNIART: Hist. Vég. Foss., p. 170, Pl. XLV, Figs. 3–7.

1894. *Onychiopsis mantelli* SEWARD: Wealden Plants, Pl. I, p. 41, Pl. II, Fig. 1; Pl. III, Figs. 1–4.

---

[1] E. W. BERRY: Contributions to the Palaeobotany of Peru, Bolivia and Chile. John Hopkins Univ. Stud. Geology, No. 4, 1922, p. 35.
[2] M. YOKOYAMA: Mesozoic Plants from Kozuke, Kii, Awa and Tosa. Journ. Coll. Sci., Imp. Univ. Tokyo, Vol. VII, Pt. III, 1894, p. 218, Pl. XXVII, Figs. 1, 1a.
[3] H. YABE: Mesozoische Pflanzen von Omoto. Sci. Rep. Tôhoku Imp. Univ. Sendai, 2nd Ser. (Geology), Vol. I, No. 4, 1913, p. 4, Pl. I, Fig. 10.
[4] H. YABE, T. NAGAO and S. SHIMIZU: Cretaceous Mollusca from the Sanchû Graben in the Kwantô Mountainland, Japan. Sci. Rep. Tôhoku Imp. Univ. Sendai, 2nd Ser. (Geology), Vol. IX, No. 2, 1926, p. 4.
[5] H. YABE: Mesozoic Plants from Korea. Journ. Coll. Sci., Imp. Univ. Tôkyô, Vol. XX, Art. 8, 1905, p. 32, Pl. II, Fig. 1; Pl. III, Figs. 12, 13.
[6] W. M. FONTAINE: In WARD's Status of the Mesozoic Floras of United States. U. S. Geol. Surv., Mon., Vol. XLVIII, 1905, p. 552. Pl. CLXVI, Figs. 3, 4.
[7] E. W. BERRY: Maryland Geological Survey. Lower Cretaceous, 1911, p. 243, Pl. XXIX, Figs. 1, 2.
[8] W. DUNKER: Monographie der norddeutschen Wealdenbildung. *Loc. cit.*, p. 6, Pl. IX, Fig. 10.
[9] W. DUNKER: Monographie der norddeutschen Wealdenbildung. *Loc. cit.*, p. 7, Pl. IX, Fig. 8.

1913. *Sphenopteris* (*Onychiopsis* ?) *psilotoides* HALLE: Some Mesozoic Plant-bearing Deposits in Patagonia and Tierra del Fuego and Their Floras. Kgl. Svensk. Vet.-Akad. Handl., Vol. 51, No. 3, p. 29, Pl. II, Figs. 9, 10.

1926. *Onychiopsis mantelli* NAGAO: On Some Facts concerning the Mesozoic Formation in Arita-gun, Prov. Kii; *loc. cit.*, p. 380.

1927. *Onychiopsis psilotoides* YABE: Cretaceous Stratigraphy of the Japanese Islands; *loc. cit.*, p. 41.

To the well-known Wealden fern *Onychiopsis psilotoides* there are assigned here a number of excellently preserved delicate specimens which bear a close resemblance to most of the specimens hitherto described under the specific name above referred to or as *O. mantelli*, which is synonymous with the former.

The best specimen is the one in Fig. 8. It consists of a middle portion of two bipinnate fronds arranged in parallel, and is more than 6 cm. in length. The pinnae are slender, linear in outline, generally 2 cm. in length, and attached to the rachis in alternate or subopposite, making rather acute angles with the rachis. The pinnules are small, lanceolate, and attached to the rachis at more acute angles. Another good specimen is shown in Fig. 7, while other specimens in Figs. 6, 9, 10, though fragmental, also show well the same habit of the plant.

The question of the specific relation between the European *O. psilotoides* and the Asiatic *O. elongata* (GEYLER) has long been disputed by several authors, some considering them as conspecific, while others consider them as specifically distinct. It is indeed very difficult to distinguish both forms upon sterile fronds only, and the fertile specimens discovered in Europe and Asia are also very similar in form to each other. SEWARD[1] once thought that a certain difference exists between the two types of fertile pinnules, but later[2] rather tended to the view that the two forms are specifically identical. In my opinion, however, the fertile pinnules of *O. psilotoides* and *O. elongata* can be distinguished from each other as Prof. YABE[3] has already shown those of the former, as SEWARD figured, being sessile and acuminated at the apex, while those of the latter are definitely stalked and usually obtusely rounded at the apex. It is probable, or even possible, that the present specimens all sterile, may belong to *O. elongata*, as this species is a very common plant in the Japanese Ryôseki and Tetori Series; the sterile pinnules of *O. psilotoides*, as SEWARD once pointed out, are generally smaller than those of *O. elongata*, and the Takata specimens show a striking resemblance to this species and especially to one of the specimens as figured by BRONGNIART[4] in his "Histoire" as *Sphenopteris mantelli*, and the lower portion of a large specimen figured by SEWARD[5] from the Wealden strata of Ecclesbourne. Therefore, though with some hesitation, I have now decided to assign them to the European species *O. psilotoides*.

FONTAINE distinguished more than forty species of *Thyrsopteris* from the Potomac and BERRY[6] recognised only five species of *Onychiopsis* among the numerous specimens; the latter author is probably correct in considering *O. psilotoides* and *O. elongata* specifically distinct, but there is a little doubt about his opinion that *O. elongata* is identical with a specimen referred by SCHENK to

[1] A. C. SEWARD: Wealden Plants, Pt. I, 1894, p. 41–60.
[2] A. C. SEWARD: Fossil Floras of Cape Colony. Ann. S.-African Museum, Vol. IV, Pt. I, 1903, p. 5.
[3] H. YABE: Mesozoic Plants from Korea. Journ. Coll. Sci., Imp. Univ. Tôkyô, Vol. XX, Art. 8, 1905, p. 25.
[4] A. BRONGNIART: Histoire des végétaux fossiles, 1829, Pl. 45, Figs. 3-7.
[5] A. C. SEWARD: Wealden Plants. *Loc. cit.*, Pl. II, Fig. 1.
[6] E. W. BERRY: Maryland Geological Survey. Lower Cretaceous. *Loc. cit.*, pp. 267–284.

Sphenopteris goepperti. Some specimens from Alaska referred by FONTAINE[1] to *O. psilotoides* which, according to KNOWLTON,[2] is identical with *Cladophlebis alata* FONT., rather resemble *O. elongata* than the typical specimens of *O. psilotoides.*

Sphenopteris goepperti DUNKER

Pl. XXXVI (I), Figs. 11–12.

1913. *Sphenopteris (Ruffordia) goepperti* HALLE: Some Mesozoic Plant-bearing Deposits in Patagonia and Tierra del Fuego and their Floras. Kgl. Svensk. Vet.-Akad. Handl., Bd. 51, No. 3, p. 30, Pl. 2, Fig. 4–8; Pl. 4, Fig. 10.

1922. *Sphenopteris (Ruffordia) goepperti* YABE: Notes on Some Mesozoic Plants from Japan, Korea and China; *loc. cit.*, p. 4, Pl. III, Fig. 5.

1926. *Ruffordia goepperti* NAGAO: On Some Facts concerning the Mesozoic Formation in Arita-gun, Prov. Kii; *loc. cit.*, p. 380.

1926. *Acrostichopteris longipennis* NAGAO: *ibid.*, p. 380.

1927. *Sphenopteris geopperti* YABE: Cretaceous Stratigraphy of the Japanese Island; *loc. cit.*, p. 41.

1927. *Acrostichopteris* cfr. *longipennis* YABE: *ibid.*, p. 41.

For further references see YABE, 1922, *loc. cit.*

In the collection, there are a number of specimens which agree more or less closely with the sterile frond of a well-known species *Sphenopteris (Ruffordia) goepperti* DUNKER.

The frond of this species is generally subjected to a great variation in the degree of dissection of the lamina, and it is often impossible to settle the specific limit among the sterile fronds of the species of *Onychiopsis* and *Ruffordia goepperti.*

A specimen in Fig. 11 is a very dissected form, and it is very difficult to describe its mode of dissection in detail. The long and narrow ultimate segments have more than one nerve, but the exact number in a segment can not be made out. The narrow segments and the slender habit of this specimen agree closely with a specimen figured by SEWARD[3] from the Wealden strata of Ecclesbourne, and there can hardly be any doubt of its belonging to the same species. Another specimen in Fig. 12 has broader pinnules than the former, and also shows a striking resemblance to a specimen figured in SEWARD's Wealden Plants, Pt. I, Pl. V, Fig. 3.

In 1926, Dr. NAGAO[4] cited *Acrostichopteris longipennis* FONTAINE, and in 1928, Prof. YABE[5] *A.* cfr. *longipennis* Font., in the list of plants from the plant-bed of Takata, on my provisional determination. The specimen assigned to FONTAINE's species, though not illustrated at this place, is a small portion of a frond, and closely resembles a specimen of *A. longipennis* figured by BERRY[6] from the Potomac of Virginia but not the original specimens of FONTAINE. After a

[1] W. M. FONTAINE: In WARD's Status of the Mesozoic Floras of United States. U. S. Geol. Surv., Mon., Vol. XLVIII, 1905, p. 155, Pl. XXXIX, Figs. 3–6.

[2] F. H. KNOWLTON: The Jurassic Flora of Cape Lisburn, Alaska. U. S. Geol. Surv., Prof. Paper, 85-D, 1914, p. 49, Pl. V, Figs. 3, 4; Pl. VI, Fig. 4.

[3] A. C. SEWARD: Wealden Plants, Pt. I, 1894, Pl. V, Fig. 1.

[4] T. NAGAO: On Some Facts concerning the Mesozoic Formation in Arita-gun, Prov. Kii. *Loc. cit.*, p. 380.

[5] H. YABE: Cretaceous Stratigraphy of the Japanese Islands. *Loc. cit.*, p. 41.

[6] E. W. BERRY: Maryland Geol. Surv. Low. Cret. *Loc. cit.*, Pl. XXIV, Fig. 7.

thorough study, however, I decided to choose *Sphenopteris goepperti* as a more suitable designation for the specimen, on the ground that the BERRY's specimen in Fig. 7, Pl. XXIV, which is quite distinct from other specimens referred by the same author to *A. longipennis*, and also from FONTAINE's specimens, is, as HALLE[1] pointed out, hardly distinguishable from a type of *R. goepperti* as figured by SEWARD[2] in his Wealden Plants.

Carpolithus sp.

Pl. XXXVI (I), Fig. 13.

Fig. 13 shows an impression of a compressed seed which can not be attributed to any special genus or group. It is broad fusiform in outline, both ends ending rather abruptly in acute apex, 1.5 cm. in length and 0.7 cm. in breadth. The surface of the seed is broadly wrinkled longitudinally, possibly due to compression after it was embedded in the matrix. It may also likely be a tuber of an Equisetacean root, but as there is no underground stem in organic connection with the tuber-like object, the generic name *Carpolithus* is provisionally applied to this specimen.

On the Geological Age of the Plant-beds of Takata

The fossil plants derived from Takata contain only 6 species, v.z., 1 Equisetales, 4 Filicales and 1 seed of doubtful affinity. They are:

Equisetites sp.	Rare
Cladophlebis browniana (DUNKER)	Common
Cladophlebis? sp.	Rare
Onychiopsis psilotoides (STOKES and WEBB)	Abundant
Sphenopteris goepperti DUNKER	Common
Carpolithus sp.	Rare

Cladophlebis browniana and *Sphenopteris goepperti* are the commonest species of the Wealden, and quite common also in our Ryôseki[3] Series. *Onychiopsis psilotoides* is a well-known species of the Wealden and the Potomac, and is also represented in our Ryôseki Series by a very closely allied form *O. elongata* (GEYLER). Even though the whole number of the species here discriminated is confined to 6, and only three of them are specifically determined, yet they contain the characteristic elements of the Ryôseki of Japan, the Wealden of Europe and the Potomac floras of North America, and it is quite likely that the plant-beds of Takata are also approximately contemporaneous with the floras above enumerated, if the present determination of the fossils plants is assumed to be correct. It is certain that *C. browniana* and *S. goepperti* exist also in our Tetori flora,[4] which is now generally regarded as representing more than one flora of geologically varied stages ranging from the Middle to the Upper Jurassic, or even as young as the Ryôseki Series in its upper part, while it is notable that the Takata plant-beds do not contain any species indicating an aspect older than the Upper Jurassic and that the rocks lying below

[1]T. G. HALLE: Some Mesozoic Plant-bearing Deposits in Patagonia and Tierra del Fuego and Their Floras. *loc. cit.*, p. 31.
[2]A. C. SEWARD: Wealden Plants. *Loc. cit.*, Pl. V, Fig. 3.
[3]M. YOKOYAMA: Mesozoic Plants from Kôzuke, Kii, Awa and Tosa. *Loc. cit.*, p. 212.
[4]M. YOKOYAMA: Mesozoic Plants from Kôzuke, Kii, Awa and Tosa. *Loc. cit.*, p. 212.

the plant-beds and entirely exclusive of marine indications overlie unconformably the older rocks. Under these circumstances, I think it favourable to regard the plant-beds at Takata as corresponding to the Ryôseki Series, which, according to the re-defined sense of Prof. YABE,[1] is "the product at the time of marine regression which took place between the Jurassic and the Cretaceous in the Japanese Archipelago," and thus not older than the Upper Jurassic and not younger than the Monobegawa Series[2] which indicates the Upper Hauterivian and Barremain in age in its lower part.

II. NOTES ON SOME FOSSIL PLANTS FROM KOREA

In Part II, I wish to deal with three interesting forms of fossil plants derived from the different localities in the Kôbôsan district and its vicinity, in the Hei-jô coal-field, Korea. The species described are as follows:

Protoblechnum wongii HALLE. Chôhei-zan, Ringen-men, Daidô-gun, Heian-nan-dô. (Reg. No. 38002).

Protoblechnum? sp. Shinsô-dô, Bantatsu-men, Kôtô-gun, Heian-nan-dô. (Reg. No. 38233, 38234).

Palaeovittaria? koreanica ÔISHI n. sp. Yôhô, Ringen-men, Daidô-gun, Heian-nan-dô. (Reg. No. 38083).

Among these, *Protoblechnum?* sp. and *Palaeovittaria? koreanica* are from the collection of Professor H. YABE and kindly submitted by him to the writer for examination in the summer of 1928, but, for several reasons, the description of the material has been postponed till now. *Protoblechnum wongii* Halle was collected by Dr. S. TOKUNAGA many years ago, and was recently donated to our Institute of Geology and Palaeontology.

DESCRIPTION OF THE SPECIES

Protoblechnum wongii HALLE

Pl. XXXVI (I), Fig. 27.

1927. *Protoblechnum wongii* HALLE: Palaeozoic Plants from Central Shansi. Pal. Sinica, Ser. A, Vol. II, Fas. I, p. 135, Pls. XXXV, XXXVI; Pl. LXIV, Fig. 12.

1928. *Protoblechnum wongii* YABE and ÔISHI: A Note on *Protoblechnum wongii* HALLE. Jap. Journ. Geol. Geogr., Vol. VI, Nos. 1–2, p. 61, Pl. XII.

The specimen in Fig. 27 shows more than four, long and narrow pinnules, which are placed on one side of the rachis, in parallel and overlapping each other. A nearly complete pinnule in the lowest position of the figure attaches distinctly to the strong rachis at an angle of 35°. The breadth of the rachis is 4 mm. on the impression and its surface bears numerous, fine, discontinuous, longitudinal striations. The pinnule is linear-lanceolate, straight, 9.5 cm. in length,

[1] H. YABE: Cretaceous Stratigraphy of the Japanese Islands, *loc. cit.*, p. 67. "The array of stratigraphical facts and palaeogeographical conditions, outlined above, seems to warrant the conclusion that there exists in the Japanese Islands a series, mostly of fresh and brackish water deposits, which is the product of a time of marine regression. This approximately coincides with the time of transition from the Jurassic Period to the Cretaceous in the European standards. This series should be taken as the mark of the Jurassic-Cretaceous Boundary in the Japanese Islands and should be considered as transitional deposits between the Jurassic and the Cretaceous. To this series should be applied the name Ryôseki Series."

[2] H. YABE: Cretaceous Stratigraphy of the Japanese Islands; *Loc. cit.*, p. 69.

and broadest, measuring 1.7 mm. at the part nearly one-third from the base, thence attenuating gradually towards the apex which, though broken at its very tip, is probably bluntly pointed, and contracts rather abruptly towards the base in the upper margin, and gradually merges into the decurrent wing of the pinnule in the lower, without special contraction. The midnerve is rather strong, being elevated from the surface of the lamina as a ridge, and dissolves into the lateral nerves at a short distance from the apex. The lateral nerves, arising from the midnerve at an acute angle, are fine and crowded, arching and once or twice dichotomising near the midnerve. Similar fine nerves issue directly from the rachis in the decurrent wing.

As to the Chinese species once referred to *Protoblechnum*, v.z., *P. wongii* HALLE from the Upper Shih-ho-tse Series of Central Shansi and *P. hallei* YABE and ÔISHI from the Chan-chiu coal-field in Prov. Shantung, D. WHITE[1] recently expressed his opinion that they should be transferred to the genus *Glenopteris* Sellards, on the ground that *Protoblechnum* is hitherto known only from the Upper Potsville of Ohio, while *Glenopteris* is from the Wellington Shale of Kansas, younger than the former. Though Dr. WHITE lays stress on the geological age of the rocks in which *Protoblechnum* and *Glenopteris* are found in North America, yet it is by no means improbable that *Protoblechnum* occurs also in a still higher horizon in China or elsewhere, and it seems to me better to use LESQUEREUX's generic name for the Asiatic specimens which, as HALLE pointed out, agree well with the type-species of *Protoblechnum Alethopteris holdeni* LESQX., especially in the abrupt reduction of pinnules towards the apex of the frond, a feature considered by SELLARDS to be the essential generic feature of *Protoblechnum* distinctive from his *Glenopteris*.

The specimen is easily distinguished from *P. hallei* YABE and ÔISHI[2] from the Hei-shan mine, Prov. Shantung, in the size and form of the pinnules; on the contrary, it is almost impossible to find the specific distinction between the Korean specimen and *P. wongii* in all respects (compare with HALLE's Pl. 35, Fig. 1; Pl. 36, Fig. 3, etc.). Recently Prof. YABE and I[3]) noted the occurrence of this species also in the coal-bearing series of the Chan-chiu coal-field, Prov. Shantung, China, represented by some imcomplete specimens, but showing distinctly characters available for specific identification to HALLE's species.

It is notable that this species characteristic of the Shi-ho-tse flora of Central Shansi is now found also in the plant-bed of Chôheizan of northern Korea, which is thought by Prof. YABE stratigraphically to occupy the intermediate horizon between the plant-bed of Chikandô with *Gigantopteris dentata* YABE,[4] *Neuropteridium coreanicum* KOIWAI,[5] *Pecopteris orientalis* (SCHENK), etc. and the Kôbôsan Series in the sense of the geologists of the Geological Survey, Government-General of Korea.

Besides this species, the collection of our Institute from Chôheizan contains *Neuropteridium coreanicum* KOIWAI (Reg. No. 30675), *Neuropteridium?* (Reg. No. 30690), *Pecopteris heijoensis* (Tok.)=*P. orientalis* (SCHENK) (Reg. No. 30141), *Eucordaites principalis* (GERM.) (Reg. No. 22193), *Cordaites* (Reg. No. 30446), *Cordaites* (or *Noeggerathiopsis hislopi* BUNBURY) (Reg. No. 30543), *Plagiozamites planchardi* (RENAULT) (Reg. No. 8688, 30683).

Locality: Chôhei-zan.

---

[1] D. WHITE: Flora of the Hermit Shale, Grand Canyon, Arizona. Carnegie Institution of Washington Publ. No. 405, 1929, p. 33 and following.

[2] H. YABE and S. ÔISHI: A New Species of *Protoblechnum* from the Hei-shan coal-field in Shantung. Jap. Journ. Geol. Geogr., Vol. VI, Nos. 1-2, 1928, p. 15, Pl. V.

[3] H. YABE and S. ÔISHI: A Note on *Protoblechnum wongii* Halle. *Ibid.*, p. 62.

[4] H. YABE: Geological and Geographical Distribution of *Gigantopteris*. Sci. Rep. Tôhoku Imp. Univ., Sendai, 2nd Ser. (Geology), Vol. IV, No. 2, 1917, p. 55 (1).

[5] K. KOIWAI: On the Occurrence of a New Species of *Neuropteridium* in Korea and its Geological Significance. Sci. Rep. Tôhoku Imp. Univ., Sendai, 2nd Ser. (Geology), Vol. XI, No. 1, 1927, p. 23 (1).

Protoblechnum ? sp.

Pl. XXXVI (I), Figs. 14–26.

A number of fragmental specimens from Shinsô-dô, which can not definitely be attributed to any genera and species hitherto known, is here provisionally assigned to *Protoblechnum*. As it is questionable whether all the specimens at hand may really belong to one and the same species, I think it the best to consider each specimen separately.

The specimen Fig. 14 shows two pinnules or segments apparently in opposite or subopposite and attached to the axis at wide angles; the left one bends strongly downwards probably subjected to the partial displacement of the matrix of that part. However, it is not certain whether this specimen represents a portion of a plant leaf with dichotomous habits, or with segments apically branching, or shows two segments from the apical end of a leaf, or rather a pinnate leaf in which only two pinnules are here seen and broken thence upwards. The supposed pinnule or segment directed to the right is more than 6.5 cm. long, incomplete distally, and decurrent at the lower base making a broad wing, while contracting rather abruptly at the upper base. The midnerve is prominent, and sends off fine, crowded, straight, dichotomous lateral nerves at very acute angles. In the wing, the decurrent fine nerves corresponding to the lateral ones are issued directly from the rachis. Figs. 15 and 16 show well the nature of the base of the pinnule, the upper base contracting abruptly and making a deep sinus. The broad wing at the lower base of the pinnule is seen in Fig. 17. It is apparently very large in size, and has parallel, fine, and crowded nerves which depart from the axis at acute angles, soon bend outwards almost at right angles to it, and reach to the outer margin of the wing after frequent bifurcation. Fig. 18 shows a part of the wing near the axis and shows the same nervation as the specimen in Fig. 16.

There are some more fragmental specimens of the pinnules which do not show any attachment to the axis; they are shown in Figs. 19–26. It is probable that the specimens in Figs. 23–26 represent partial fragments of the pinnules of such a specimen as in Fig. 14, coinciding with each other in the nervation and the general habit of the pinnules, while, on the contrary, the laminae in Figs. 19–22 are decidedly larger than any of the other specimens and seem to belong apparently to a quite different plant. Excepting the specimen in Fig. 20, all the others are certainly traversed by a distinct midnerve, which, in the specimen in Fig. 22, persists to the top of the segment, and sends off fine crowded lateral nerves at acute angles.

It is a matter of much difficulty to find out the general characters of this plant from such small pieces of specimens; as a whole, however, the specimens here figured are all derived from one bed, and have their peculiar nervation in common, and it is not quite impossible to compare them with certain similar plants previously recorded.

The present specimens, though only partially, recall to us *Odontopteris sibirica* ZALESSKY[1] figured by ZALESSKY from the Angara Series of the Kusnetzk Basin in Siberia on the one hand, and *Psygmophyllum multipartitum* HALLE[2] figured and described by HALLE from the Upper Shiho-tse Series of Central Shansi in China on the other. Our specimens, however, are distinct from both the Chinese and the Siberian species at least in having a peculiar broad wing at the lower base of the pinnules, and in this particular they resemble more *Protoblechnum wongii* HALLE[3]

[1] M. D. ZALESSKY: Flore palézoique de la série d'Angara. Mém. Com. Géol. Pétrograd, N. S. Liv. 174, 1918, Pls. 41, 42, 43.

[2] T. G. HALLE: Palaeozoic Plants from Central Shansi. Pal. Sinica, Ser. A, Vol. II, Fas. 1, 1927, p. 215, Pls. 57, 58.

[3] T. G. HALLE: Palaeozoic Plants from Central Shansi. *Loc. cit.*, p. 135, Pls. 35, 36; Pl. 64, Fig. 12.

from the Shi-ho-tse Series of Central Shansi, which differs from them slightly in having arching ateral nerves. In the straight lateral nerves, the Korean specimens resemble strongly *Thinnfeldia* sp. described by ZALESSKY[1] from the Angara Series of Maraia Sitsa, and both forms seem to be specifically almost identical. In the absence of the peculiar wing in the Siberian plant, however, it is impossible to treat them as strictly identical. At any rate, a *Protoblechnum*-like aspect being very strong in our specimens, I have ventured provisionally to refer them to this genus.

The specimens were found in association with some other imperfect specimens belonging to *Pecopteris orientalis* (SCHENK) (Reg. No. 38011), *Taeniopteris* cfr. *norini* HALLE (Reg. No. 38019), *Taeniopteris?* spp. (Reg. Nos. 38015, 38020), *Taeniopteris* sp. (Reg. No. 38023), *Chiropteris?* sp. (Reg. No. 38018), *Neuropteris* sp. (Reg. No. 38026), *Tingia crassinervis* HALLE? (Reg. No. 38026), *Cordaites?* (Reg. No. 38027), *Carpolithus* sp. (Reg. No. 38010), etc.

The plant-bed which yielded these fossil plants at Shinsô-dô, according to the information kindly given by Prof. YABE, is believed to occupy stratigraphically a horizon a little lower than or almost the same as *Gigantopteris dentata*-bed of Chikandô.

Locality: Shinsô-dô.

Palaeovittaria? koreanica ÔISHI n. sp.

Pl. XXXVI (I), Fig. 26.

The leaf is thin, straight and apparently simple, more than 9.5 cm. in length, and 2.3 cm. in breadth at the broken apical end of the specimen, thence contracting very gradually towards the base, which is 0.7 cm. in breadth. The midnerve is comparatively broad, marked as a shallow furrow on the matrix and resolves into the lateral nerves at a short distance below the broken apical end. The lateral nerves, branching from the midnerve at very acute angles, are very crowded and distinct, once or twice dichotomising, arching, and never anastomosing. The margin is entire.

Though the specimen is broken off both below and above, it is well characterised in the leaf form, and especially in the nature of the midnerve which exists as a distinct structure only in the basal portion of the leaf; such characters remind us strongly of the *Palaeovittaria*, of which we know only a single species, *P. kurtzi* Feist., described originally by FEISTMANTEL[2] from the Raniganj Group in India, and later by ZEILLER[3] from the Rhaetic of Tonkin. In the Korean species, however, the lateral nerves incurve strongly instead of being straight or very slightly incurved as in the Indian species, and we believe there certainly exists a specific distinction between them. This is not unlike a certain portion of the leaves provisionally called above *Protoblechnum?* sp., in which, however, the midnerve distinctly persists up to the top of each segment, and does not resolve into the lateral nerves as in the present species. In the single habit of the leaf and in the nature of the lateral nerves, this is also comparable to the Upper Carboniferous and Lower Permian plant of the genus *Lesleya*, but in this plant the leaves are generally oval-linear or lanceolate in outline and moreover are provided with a midnerve which persists to the very top of the leaf.

---

[1] M. D. ZALLESKY: Sur l'extension du continent de l'Angaride et premières données sur la flore de ses limites oussouriennes. Ann. Soc. Géol. Nord. T. LIII, 1928, p. 134, Fig. 16.

[2] O. FEISTMANTEL: The Flora of the Damuda-Panchet Division. Pts. 2-3 of Vol. III, of the Fossil Flora of the Gondwana System. Pal. Indica, Ser. XII, 1880-1881, p. 91, Pl. XLIV.

[3] R. ZEILLER: Flore fossile des gîtes de charbon du Tonkin, 1903, p. 81, Pl. XVI, Fig. 1.

Recently, ZALESSKY[1] instituted a new generic name *Scapanophyllum* for certain specimens from the Angara Series of Ussuriland, comprising all of them in only one species, *S. sitzense*. As ZALESSKY says, *Scapanophyllum sitzense* is closely related to *Palaeovittaria kurtzi*, but is distinguished from it in the entire absence of midnerve, which is replaced by a fascicle of nerves at the lower part of the leaf. *S. sitzense* and *P? koreanica* have arching lateral nerves in common, but they are distinguished from one another by the different nature of the midnerve and in this feature the two seem to be held separate at least specifically.

Even though the generic determination of the Korean specimen can not be claimed as correct, yet it is worthy of note that a form closest in leaf-form to a monotypic species, *P. kurtzi* FEIST., of the Lower Gondwona flora is also found at Yôhô in Korea. The geological age of the plant bed of Yôhô with this fossil is not yet definitely settled. There are evidences pointing to the occurrence of more than one plant-bed of quite different geological ages in an intimate stratigraphical relation at the locality.

The plant-bed of Yôhô contains, besides *P.? koreanica* n. sp., *Desmopteris? orientalis* YABE and ÔISHI (Reg. No. 22203), *P. orientalis* (Schenk) (Reg. No. 38184), *Plagiozamites* cfr. *planchardi* ZEILLER (Reg. No. 38028), *Neuropteris* sp. (cfr. *Alethopteris* sp. of Halle: Pal. Plants from Cent. Shansi, p. 111, Pl. 24, Figs. 13–15) (Reg. No. 38017), and *Callipteridium?* sp. (Reg. No. 38012).

Locality: Yôhô, Ringen-men, Daidô-gun, Heian-nan-dô, Korea.

[1] R. ZALESSKY: Sur l'extension du continent de l'Angaride et premières données sur la flore de ses limites ous sourienses. *Loc. cit.*, p. 132.

PLATE XXXVI (I)

(All figures are in natural size.)

Fig. 1. *Equisetites* sp. Takata.

Figs. 2–4. *Cladophlebis browniana* (DUNKER). Takata.

Fig. 5. *Cladophlebis?* sp. Takata.

Figs. 6–10. *Onychiopsis psilotoides* (STOKES and WEBB). Takata.

Figs. 11–12. *Sphenopteris goepperti* DUNKER. Takata.

Fig. 13. *Carpolithus* sp. Takata.

Figs. 14–25. *Protoblechnum?* sp. Shinsô-dô.

Fig. 26. *Palaeovittaria? koreanica* ÔISHI nov. sp. Locality No. 2, Yôhô.

Fig. 27. *Protoblechnum wongii* HALLE. Chôhei-zan.

Fig. 1.

Fig. 2.

Fig. 3.

Fig. 4.

Fig. 5.

Fig. 13.

Fig. 7.

Fig. 6.

Fig. 9.

Fig. 12.

Fig. 11.

Fig. 26.

Fig. 8.

Fig. 19.

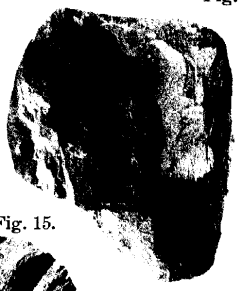

Fig. 15.

Fig. 22.

Fig. 10.

Fig. 23.

Fig. 27.

Fig. 14.

Fig. 17.

Fig. 18.

Fig. 20.

Fig. 21.

Fig. 24.

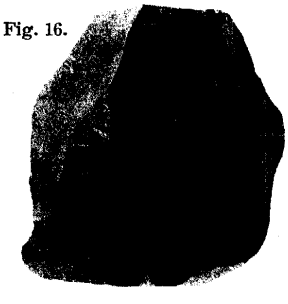

Fig. 16.

Fig. 25.

Ebina photo. and Ôishi del,